REPORT RESUMES

ED 010 307 24
REPORT OF THE FIRST RESEARCH PLANNING CONFERENCE HELD UNDER THE AUSPICES OF PROJECT LITERACY, (TITLE SUPPLIED)--PROJECT LITERACY REPORTS, NO. 1.
BY- LEVIN, HARRY AND OTHERS
CORNELL UNIV., ITHACA, N.Y.
REPORT NUMBER CRP-F-034-1 PUB DATE JUL 64
REPORT NUMBER BR-5-0617-1
CONTRACT OEC-4-10-113
EDRS PRICE MF-$0.09 HC-$1.68 42P.

DESCRIPTORS- *LITERACY, *READING, *LANGUAGE DEVELOPMENT, *COGNITIVE DEVELOPMENT, ITHACA, NEW YORK, PROJECT LITERACY

PROVIDED IN THIS REPORT ARE COMPLETE TEXTS OF THE PAPERS PRESENTED AT THE FIRST RESEARCH PLANNING CONFERENCE OF "PROJECT LITERACY." THE CENTRAL THEME OF EACH PAPER IS BASIC RESEARCH AND/OR CURRICULUM DEVELOPMENT IN AREAS OF EDUCATION RELEVANT TO THE ACQUISITION OF READING SKILLS. TITLES OF THE 12 PAPERS PRESENTED ARE (1) "AROUSAL--IMPLICATIONS FOR A LEARNING-TO-READ PARADIGM," (2) "ACQUIRED RELEVANCE OF CUES IN READING--THE LEARNING OF SELECTIVE OBSERVING RESPONSES," (3) "SYSTEMATIC INVESTIGATION OF CERTAIN VARIABLES BASIC TO THE DEVELOPMENT OF EFFECTIVE INSTRUCTIONAL SEQUENCES IN READING," (4) "READING AS A MOTOR SKILL--A MEDIATION MODEL," (5) "STIMULUS FACTORS IN LITERACY--GRAPHIC COMMUNICATION, VERBAL AND NONVERBAL," (6) "READING AS A PERCEPTUAL SKILL," (7) "NEUROPHYSIOLOGY OF RECOGNITION AND INTERSENSORY ASPECTS OF READING," (8) "EIDETIC IMAGERY IN CHILDREN--SUMMARY OF RESEARCH," (9) "RESEARCH PLANS AND PRELIMINARY RESULTS RELEVANT TO PROJECT LITERACY," (10) "COMPREHENSION WITH USE OF PHONIC TEACHING METHODS," (11) "SUGGESTIONS FOR RESEARCH ON THE USE OF THE CHILD'S KNOWLEDGE OF SPOKEN LANGUAGE IN THE TEACHING OF READING AND WRITING," AND (12) "ELEVEN HYPOTHESES IN SEARCH OF A (COGNITIVE) METHOD--NOTES ON SEMINAR TALK." (JH)

ED010307

5-0617 (F-050)-1

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education
This document has been reproduced exactly as received from the person or organization originating it. Points of view or opinions stated do not necessarily represent official Office of Education position or policy.

PROJECT LITERACY REPORTS

NO. 1

1964

DIRECTOR

Harry Levin

RESEARCH ASSOCIATE

Nancy S. Meltzer

STEERING COMMITTEE

[illegible] [illegible]

[illegible]

[illegible]

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education
This document has been reproduced exactly as received from the person or organization originating it. Points of view or opinions stated do not necessarily represent official Office of Education position or policy.

CONTENTS

Page

WHAT IS PROJECT LITERACY? 1

AROUSAL: IMPLICATIONS FOR A LEARNING-TO-READ PARADIGM 3
Yvonne Brackbill

ACQUIRED RELEVANCE OF CUES IN READING: THE LEARNING OF SELECTIVE OBSERVING RESPONSES 7
John C. Wright

SYSTEMATIC INVESTIGATION OF CERTAIN VARIABLES BASIC TO THE DEVELOPMENT OF EFFECTIVE INSTRUCTIONAL SEQUENCES IN READING 10
Joanna Williams

READING AS A MOTOR SKILL: A MEDIATION MODEL 14
Curtis Hardyck, et al.

STIMULUS FACTORS IN LITERACY: GRAPHIC COMMUNICATION, VERBAL AND NON-VERBAL 17
Julian Hochberg

READING AS A PERCEPTUAL SKILL 19
Paul A. Kolers

NEUROPHYSIOLOGY OF RECOGNITION AND INTERSENSORY ASPECTS OF READING 22
R.Wayne Jones &
Thorne Shipley

EIDETIC IMAGERY IN CHILDREN — SUMMARY OF RESEARCH 25
Ralph N. Haber

RESEARCH PLANS AND PRELIMINARY RESULTS RELEVANT TO PROJECT LITERACY 28
Anne D. Pick &
Herbert L. Pick, Jr.

COMPREHENSION WITH USE OF PHONIC TEACHING METHODS 31
Janellen Huttenlocher

SUGGESTIONS FOR RESEARCH ON THE USE OF THE CHILD'S KNOWLEDGE OF SPOKEN LANGUAGE IN THE TEACHING OF READING AND WRITING 33
Rose R. Olver

ELEVEN HYPOTHESES IN SEARCH OF A METHOD - NOTES ON SEMINAR TALK 35
Jerome Bruner

PARTICIPANTS IN PROJECT LITERACY'S FIRST RESEARCH PLANNING CONFERENCE 38

WHAT IS PROJECT LITERACY?

Project Literacy was organized at Cornell University on February 1, 1964, by a developmental projects award from the Cooperative Research Branch of the United States Office of Education. This project represents one of the major commitments of the Office of Education to basic research and curriculum development concerning both child and adult literacy.

The purpose of Project Literacy is to organize, in various universities, laboratories and state departments of education, research which is essential to understand the acquisition of reading skills. The major initial effort is to bring together researchers and educators from a variety of disciplines to plan research which, when taken as a whole, will give us more substantial results than any single study can provide. Each investigator in the research consortium will be completely responsible for his own activities. The project will provide mechanisms whereby the individual scientists can communicate their research strategies, problems and results to each other and when necessary they will be able to meet together. The research findings will be brought to bear on curriculum developments. When called upon, Project Literacy will also undertake a program of studies similar to those which will be initiated in other settings.

We believe that much current and potential research in learning psychology, visual preception, cognitive behavior, neurophysiology of vision, child development, descriptive linguistics, psycholinguistics, the sociology of educational innovation, research with culturally disadvantaged children and programmed instruction (to cite some examples) are essential to understanding literacy. Consequently, we are endeavoring to locate research interests which heretofore may not have been considered relevant to this crucial educational research area.

AROUSAL: IMPLICATIONS FOR A LEARNING-TO-READ PARADIGM

Yvonne Brackbill
University of Denver

For the last four years, this laboratory had been concerned with a project investigating the effects on retention of reinforcement delay during learning. In more than a dozen experiments with young children working under a variety of conditions, it has been found consistently that reinforcement delay facilitates retention. For the sake of brevity, this phenomenon has been called the delay-retention effect.

In trying to find the reason for the occurrence of the delay-retention effect—i.e., the improvement of retention via reinforcement delay during learning—we have been led to formulate a general hypothesis of retention. The hypothesis is this: any condition that increases arousal during learning will improve retention of the learned material. Arousal is defined, in a loose-jointed conceptual way, as increased attention to a non-threatening stimulus, and in an operational sense, as a definite response pattern in recordings of heart rate, GSR, and possibly, blood volume. One condition that increases arousal appears to be reinforcement delay during learning. Another condition may well be the level of difficulty of the learning task. If valid, the hypothesized relationship of both these factors to arousal, and the relation of arousal to retention (and to learning?) should be extremely important factors for the learning-to-read and learning-to-write situations.

The main objectives of the studies proposed at the conference are as follows: (1) to compare the relative merits of three indices of arousal—heart rate, GSR, and blood volume—and to confirm or deny the hypothesis that reinforcement delay and task difficulty are directly related to level of arousal, which in turn influences retention; and (2) to determine which of the stimulus combinations available to a teacher maximizes short-term and long-term retention of learned grapheme-phoneme associations. As an example, the plan of the second experiment is given below.

The relative effectiveness of stimulus combinations in establishing grapheme-phoneme associations.

The usual approaches to teaching a child to read can profitably be viewed as embodying a great deal of paired-associate learning. The experimental design, in Table 1, is proposed as a starting point for investigation of the process. The stimulus will be the written word alone, or in combination with either or both spoken word and pictured object. All Ss will be given the same fixed number of presentations of the stimuli, and for the Ss the response will be the spoken word. Knowledge of results (the correct spoken word) and, if necessary, a token reward, will serve as reinforcement. Physiological measures will be recorded, as in the preliminary study, except that in this study half the Ss under each condition will be run without attached electrodes, as controls for possible effects of electrode attachment on learning and retention.

Table 1. Design of acquisition phase of Experiment II. N is not less than 12/cell

	Groups	Stimulus, training condition	Response
Physiological measures taken	1	Grapheme	Phoneme
	2	Grapheme + phoneme	Phoneme
	3	Grapheme + object	Phoneme
	4	Grapheme + phoneme + object	Phoneme
No physiological measures taken	5	Grapheme	Phoneme
	6	Grapheme + phoneme	Phoneme
	7	Grapheme + object	Phoneme
	8	Grapheme + phoneme + object	Phoneme

Following acquisition, the eight groups will be further subdivided according to length of time intervening between learning and tests of retention. It is proposed that both short-term and long-term measures of retention be taken—probably one day, and one week, after acquisition.

During the retention session, one unreinforced presentation of the list will be given, asking for recall of the spoken words. Then, successive reinforced runs through the list will be given, to a criterion of relearning. Results will indicate which manner of stimulus presentation maximizes retention of the grapheme-phoneme association.

SELECTED BIBLIOGRAPHY

Brackbill, Y., Wagner, J.E., & Wilson, D. Feedback delay and the teaching machine. Psychol. in the Schools, 1964, 1, 148-156

Berlyne, D.E. Conflict, arousal, and curiosity. New York: McGraw-Hill 1960.

Kleinsmith, L.J., & Kaplan, S. Paired-associate learning as a function of arousal and interpolated interval. J. exp. Psychol., 1963, 65, 190-193.

Kleinsmith, L.J., & Kaplan, S. The interaction of arousal and recall interval in nonsense syllable paired-associate learning. J. exp. Psychol., 1964, 67, 124-126.

Kleinsmith, J.L. & Kaplan, S., & Tarte, R.D. The relationship of arousal to short and long term verbal recall. Canad. J. Psychol., 1963, 17, 393-397.

Lacey, J.I. Psychophysiological approaches to the evaluation of psychotherapeutic process and outcome. In E.A. Rubinstein & M. B. Parloff (eds.), Research in psychotherapy. Washington, D.C.: American Psychological Association, Inc., 1959. Pp. 160-208.

Lipton, E.L., Steinschneider, A., & Richmond, J.B. Autonomic function in the neonate: III. Methodological considerations. Psychosom. Med., 1961a, 23, 461-471.

Lipton, E.L., Steinschneider, A., & Richmond, J.B. Autonomic function in the neonate: IV. Individual differences in cardiac reactivity. Psychosom. Med., 1961b, 23, 472-484.

Vinogradova, O.S. Specific and non-specific systems of reactions in the course of the formation of a conditioned connexion in man. Pavlov J. high. nerv. Act., 1960, 10, 518-527.

ACQUIRED RELEVANCE OF CUES IN READING: THE LEARNING OF SELECTIVE OBSERVING RESPONSES

John C. Wright
Institute of Child Development
University of Minnesota

The research that I have been pursuing for the past year or so is concerned with how young children learn to process information. In collaboration with Miss Zahn and other students I have been trying to analyze experimentally some of the mechanisms by which children learn what aspects of the stimulus situation are relevant to the solution of the problem at hand, whether it be a simple simultaneous two-choice discrimination or a complex array of ten alternatives yielding only partial reinforcement. We are approaching the problem from two different directions at once. One is the study of search behavior as it is organized in long sequences of responses during problem solving. The other is the study of observing responses in discrimination learning.

Problem solving and search behavior. Starting with the assumption that trial and error behavior is more than the natural selection of certain responses by reinforcement and the extinction of other by nonreinforcement, we have focussed on rather complex and ambiguous tasks, wherein we can study the ways in which children organize and systematize their search for a solution. We have been able to distinguish patterns and sequences of responses that are hypotheses in the process of being tested, from similar patterns that are being used as search routines by S. Systematic search is, we believe, more than just a style of approaching problems. It is a specific, organized sequence of information-producing and record-keeping behaviors that can be taught as a general strategy of approaching complex problems.

Organization of observing behavior. On a much more direct and primitive level orienting and observing behavior seems to have many of the same functional properties as does systematic search in problem solving. In both cases random querying of the environment seems to give way by age six or seven to orgaized investigation. In both cases there is a continuing interplay between, on the one hand, looking around, playing hunches, guessing, etc., and on the other hand, deliberate, sequentially organized, internally coherent looking and testing. We believe that the major function and value of both systematic search and orderly perceptual comparison is to discover what particular cues are really relevant to the problem at hand. Once the child has discovered which cues are relevant and has by his own active comparison and ordering responses outlined the reasonable possibilities for a correct response, then the process of learning any correct stimulus-response pairing is simple, rapid, and quite stable. To this end we have been studying eye and hand movements in visual and tactual discrimination learning of children.

Rather than simply photographing natural eye movements, we have devised an apparatus on which children learn to operate a level to bring either of two stimuli into focus. Thus both stimuli are continuously available but out of focus, and it takes a combination of explicit, voluntary observing responses to compare them. Working with third-graders Miss Zahn has employed a delayed reinforcement design in which all subjects must operate the lever to compare the stimuli before choosing on each trial, but also in some conditions they are permitted to continue comparing the stimuli which waiting to find out whether their choice was correct or not. Those who have the additional practice with this relevant orienting behavior not only learn quicker, but also look longer before choosing. Moreover, their more careful comparing of the stimuli continues unabated for some time after they have achieved the learning criterion. Those not permitted to practice observing and comparing during the delay interval learn more slowly, make fewer and briefer comparisons, and show decreases in frequency and duration of looking responses over trials before they have learned the discrimination.

Application to the study of learning to read. Teachers have long known that attention is one key prerequisite to learning. Our aim will be to take apart the variable of attention as it is revealed in selective and organized looking behavior in children learning to read. We hope to bring the observing behavior itself under experimental control by pre-training and then to use the observing behavior in a variety of situations where it interacts with discrimination of graphemes, acquisition of grapheme-phoneme correspondences, and whole word recognition. We plan to make heavy use of the work already accomplished by others on the critical features of letters and words. We shall be especially interested in optimizing the time relations among observational interval, response latency, frequency and duration of looking, feedback, and rehearsal of correct responses following positive and negative reinforcement. We shall attempt also to investiage the effects, both facilitating and interfering, of pre-training relevant and irrelevant observing responses.

On the side of problem solving our attention will be directed toward the influence of success and failure (levels of noncontingent reward) on guessing as opposed to systematic analysis in learning an artificial language of grapheme-phoneme correspondences. The latter research is at this time only in the discussion stage, and our plans are tentative at best.

SYSTEMATIC INVESTIGATION OF CERTAIN VARIABLES BASIC TO THE DEVELOPMENT OF EFFECTIVE INSTRUCTIONAL SEQUENCES IN READING

Joanna P. Williams
University of Pennsylvania

The primary need in reading research today is for a very careful and systematic analysis of what "reading" really is. Only after the general task has been analyzed into its components will serious advances in instruction be made. As each component skill is defined and isolated, strategies for training must be developed and assessed. While optimal training sequences may perhaps turn out to involve integrated training on several component skills at the same time, it seems reasonable to expect that the initial steps will come from investigations of each component skill considered separately.

Specification of the task components is a job in itself. For example, one of the most fundamental skills in reading is the ability to "sound out" novel grapheme combinations. Some of the components here include phoneme differentiation, phoneme blending, grapheme discrimination, associative learning of individual graphemes and phonemes (or combinations), learning to follow a left to right sequence, and transferring previously learned correspondences to novel combinations.

There are several research strategies which can be employed ranging from theoretical approaches such as that of Gibson (e.g., her set of distinctive features for graphemes) to those involving the development of an instructional sequence via "good guesses", making successive approximations toward the most effective program possible. Regardless of one's strategy, however, systematic data on basic variables in the specific context of the actual materials we wish to teach will be useful.

Listed here are several fundamental questions to be considered in choosing the order in which to introduce letters and letter combinations.

1. Following standard programmed instruction principles, should the task start off as a very simple one, and gradually increase in difficulty?
   - (a) Should there be "maximum contrast" between the items presented initially, and then a gradual decrease in contrast? For example, should the child learn to discriminate the graphemes o and t before he is presented with b and d?
   - (b) Is it more important that the graphemes or the phonemes be well-differentiated? In general, pre-differentiation and familiarization training on the response side proves more effective. Does this principle hold for these specific materials? If so, then perhaps sequences should be designed so that the phonemes are maximally contrasted at first (i.e., u vs. n would be presented much earlier than b vs. p).
2. How much of the material should be presented at one time? This, of course, is the classic issue of whole *vs.* part learning, recently revived by Suppes.
3. What performance level should be attained before going on to the next task in the training sequence? Should there be training on each item, or on each component, until a very high criterion is reached (e.g., Fries "automatic habits")? Or, on the other hand, should the training program move along so that S never is thoroughly competent and confidental at any one state (as recommended, for example, by O. K. Moore)?

The following experiment is suggested as a starting point:

Pretraining: Each subject (kindergarten age) will be pre-trained at one combination of levels of these two factors:

1. Predifferentiation of the phoneme combinations (responses): None, Low and High levels of training, the highest of which will produce substantial overtraining on this task.
2. Predifferentiation of the grapheme combinations (stimuli): Three levels as above.

Training: A list of simple 1:1 grapheme-phoneme correspondences (combinations) will be learned. A constant number of anticipation trials (experimenter-paced) will be given, on which S will be required to pronounce the phoneme combination when the grapheme combination is presented.

Both acquisition and retention will be studied. Will the results differ as a function of the amount of training given on the correspondences? Errors will also be analyzed, in order to determine whether particular kinds of errors tend to be made as a function of pretraining condition. The efficiency of teach training condition will also be assessed.

If the results prove interesting, the experiment might be extended to include other list lengths, as an initial step in studying the amount of material parameter.

Effect of Consecutive Vs. Concurrent Presentation on the Association of two Verbal Responses with a Single Referent

I. Background

A. Grapheme-phoneme correspondences

1. Bloomfield recommends that only one correspondence should be taught at a time; only after a high learning criterion has been reached should another phoneme associated with that grapheme be introduced.

2. Levin argues that both correspondences should be developed at the same time and has data to support his diversity hypothesis.

B. Second-language learning

1. "Naturalistic" observations such as Leopold's suggest that children who learn two languages concurrently experience confusion.
2. Recent experiments by Levin and by Singer, on the other hand, indicate that concurrent training is more effective.

II. Research Plan

A. Subjects: fourth grade children

B. Modification of previous studies: Materials will reflect more clearly the natural situation, e.g., meaningful stimuli (pictures of common, familiar objects) will be used.

C. Additional variables

1. Did the cue that indicated the "language" to which each response term belong influence the results? Groups run with such a cue and with no cue will be compared. (If the cue-present condition produces superior results, the suggestion might be made that children being trained in two languages should hear each language consistently from the same people, etc.)
2. In the consecutive training, the degree of proficiency on the first language before the second language is introduced will be varied. A high level of proficiency before switching will probably lead to greater differentiation and isolation of the two response sets, and may increase the effectiveness of consecutive training as compared with concurrent training.

READING AS A MOTOR SKILL: A MEDIATION MODEL

Curtis Hardyck
Lewis F. Petrinovich
Thomas Schipp

University of California Medical School
San Francisco

The five studies proposed share a common conceptual framework. In this framework, which is based on a mediational model of learning, the process of learning to read is conceptualized as a motor skill which develops through several stages of integration until a final neural analogue is established. In this conceptualization, the preliminary stages of learning to read are linked closely with a set of sounds that are the auditory counterpart of what is initially a perceived object. The next stage of development is forming the link that occurs with seeing pictures with this sound, and as a final preliminary stage, developing the relationship between a set of symbols, a picture, the object itself and the set of sounds.

In this model, next to the object itself, the sounds provide the richest and most constant source of stimulus support extending over the entire range of stimuli to which the identifying response is generalized. This offers in many ways a more solid base for generalization than the original object. Consequently, it would seem that the vocalization of sounds associated with learning objects and concepts provides the richest constant source of stimulus support during the early stages of association and generalization.

The preliminary stages in this model refer to those periods when the child (1) has learned by rote, a set of symbols associated with a story that has been read to him many times; (2) has begun to learn these symbols by himself but uses the sounds as a reference or resource in checking himself on the meaning of a set of symbols.

Once the above preliminary stages have been mastered, the overt vocalization which has been preeminent until now is replaced by another stage of integration in which the gross vocal movements drop out to be replaced by subvocalizations or vocalizations far below the normal conversational level. This pattern is present during the stages when the initial elements of the task of learning to read have been mastered but the elements of skill and speed are as yet undeveloped. Once the level of integration of the reading response has reached a certain level, the subvocalization disappears, to be replaced by a neural analogue of this process which allows a high level of skill and speed. Steps in developing this neural analogue in certain ways parallels the original process and perhaps is isomorphic to the motor development pattern. The individual may be able to read rapidly, but hear the words as he reads, or he may be able to read almost entirely on the basis of a set of symbols which by now need no primary stimulus reference.

It is proposed to test the above model by a series of studies:

1. One study is normative in character, requiring a longitudinal follow-up of children learning to read. In this study, electromyograms of the vocal muscles and other measures would be obtained on children over a period of several years.
2. A study of the relationship of difficulty to subvocalization. This study will experimentally vary material of different difficulties and measure tendencies toward sub-vocalization in relation to difficulty levels. By experimentally varying the difficulty level of the material read, using both vocal and more general measures of muscular activity

as dependent variables, a post hoc test of the model will be possible.

3. The third study is a replication, with improved controls, of some work already done in thes area. In this study, college students who subvocalized were treated by amplifying of the vocal muscles during reading and having the subject listen to it over earphones. The subject was instructed to read while keeping the noise in the earphones to a minimum. Preliminary results indicate that this continuous feedback technique is quite successful in reducing the amount of subvocalization.
4. If the mediation model is correct, elimination of subvocalization by the feedback technique used above should result in either facilitation or inhibition of reading speed, depending on the stage of development of the subject at the time the feedback technique is administered.
5. A fifth study will take advantage of a rather unique patient population. Patients who are to undergo surgery for cancer of the larynx will be studies by electromyographic techniques prior to surgery. Following surgery, electromyographic studies of muscle activity during reading while the patient is learning esophageal speech can be done.

STIMULUS FACTORS IN LITERACY: "SHAPING" VERBAL AND NONVERBAL GRAPHIC COMMUNICATION

Julian Hochberg
Cornell University

Learning to read is probably not a central problem in literacy in its broader sense: since children occasionally teach themselves to read with little or no assistance, devising instructional procedures cannot be insuperably difficult; furthermore, innumerable people who can read are functionally illterate, because they won't consume the printed word unless embedded in certain kinds of pictorial content.

The main problem seems to me to be one of motivation, of interest, therefore, not of learning.

I am concerned with the uncovering and evaluating the various stimulus determinants of graphic reinforcement and interest — the characteristics of such picture-text amalgams as picture books, illustrated magazines, and even comic strips, which, when successful, instigate and maintain reading behaviors. Some graphic displays are essentially "teaching machines"; most are not. When we understand the successful ones, we shall be able at will to induce self-instructional reading behaviors in young children, both for its own sake, and so that we can study how this apparently painless process can be applied to others, and we shall be able to extend literacy to the functionally illiterate.

As a start: pictures provide graphic interest to picture-text amalgams in two ways: (A) Pictures are intrinsically more attractive or attensive than text. (B) Pictures are more informative in many ways (and without special educational procedures required to absorb the information) than text. In both cases, questions of balance, of optimal redundacy, of desirable kinds of specialization between the two media (or components), suggest themselves after even the most cursory study of the problem. We are making fair progress in measuring contributory stimulus factors, substantive or meaningful as well as "mechanical" or compositional (measuring the substantive stimulus factors by the value of a given picture of sequence for reducing the equiprobability of alternative interpretations or "endings" of ambiguous text segments), but important sources of variance still elude us.

Dependent variables are: For class A factors: units of display (pages, "frames" in comic strips, etc.) perused ad lib, recorded by covert observers; covert gaze records via concealed cameras; reading comprehension tests. For class B factors: reluctance to interrup perusal of experimental book or strip; resistance to satiation (or tolerance of repetitions) before relapsing to idleness in a "cover task" of waiting for an experimental interview; most ambitious, but as yet unattempted: a covert eye-recording device which will measure when the reader "defocusses" his eyes and "woolgathers".[1]

---

[1] The last measure depends on the feasibility of a new instrument, now being constructed in pilot form, which is worn like spectacles and which yields digital output concerning the position of each eye in its socket, thus permitting measuring both the fixation point of the reader and the degree of convergence (which is an index of accommodation or focus); because of its digital output, records should be readily analyzable, and the immediate control of stimulation, via feedback programs, becomes possible: thus when the reader stops concentrating on a page, or fixates for too long a period, a bell can ring, or more dramatically, the display at which the eye is directed may itself be changed, stabilized, etc.

READING AS A PERCEPTUAL SKILL

Paul A. Kolers
Research Laboratory of Electronics
Massachusetts Institute of Technology

Reading is pre-eminently a psychological process. There are many thousands of alphabets, and each is as good as any other as the medium of information exchange: the stimulus materials (the characters) are entirely arbitrary, the skilled reader is often indifferent to variations in the form of the stimulus (font, size, and the like), and most often, barely "sees" the stimulus at all. Skilled reading extracts "information" from the visual array, not visual targets, but we know very little of how this information-extracting takes place.

Two sets of experiments were designed to study this process of extracting information; in method, they required subjects to read materials that had been transformed either temporally or spatially.

In one set of experiments, college students tried to recognize words presented one letter at a time in identical positions on a projection screen. Some of the words were categorially ambiguous; consisting of six letters, they can be read as two three-letter words or as one six-letter word. Examples are CARROT, COTTON. The duration for which the letters were presented, and the length of the blank pause between the offset of the third and the onset of the fourth letters were varied. Other kinds of words—indivisible six-letter units (ORANGE) or two three-letter (CUP BOY) also were presented. The principal findings were that a single six-letter word is easier to detect than two three-letter words, and that categorially ambiguous six-letter words are easier to detect than indivisible ones, at all letter durations. The import of the latter finding is unclear for the moment. Also, at letter durations below about 100 milliseconds, a curious and interesting anagramic effect occurs: the subjects can detect all the letters, but report them in incorrect sequence. This was especially noticable with nonsense syllable stimuli, although it occurred as well with words.

In a second set of experiments, subjects were required to read normal English text that had been subjected to geometric transformations: rotation, inversion, reflection, and letter reversal. The transformations, while logically equivalent, are not perceptually equivalent: a clear rank-ordering is apparent in their readability. Of greater interest than mere difficulty, is the way subjects learn to read the transformations. When first presented with a page of transformed text, the subjects deliberately and carefully figure out the nature of the transformation; their reading at this stage can be characterized as a problem-solving process. Practiced with one page of each of eight transformations on each of eight days, the subjects rapidly discard this problem-solving approach, and merely "read", much as they would normal text, albeit somewhat slower. Their spontaneous comments indicate that their comprehension of the material is minimal at the earlier stages, but improves with their skill. In a subsidiary experiment, two groups of subjects read five pages of one kind of transformed text (mirror reflection) on each of five successive days. Twenty-one of the pages were read with one eye only, the remaining four with the other eye only. Transfer between eyes was virtually perfect. However, of the subjects, a few were

Americans majoring in Middle-Eastern studies with a reportedly good reading knowledge of at least one Semitic language (typically Hebrew or Arabic), languages which are read from right to left. These subjects were far superior to the others in their ability to read English text from right to left. We assume their greater skill came from practice in processing written material from right to left, not from practice in reading English in mirror reflection.

Two qualitative observations finish this summary. One is that a subject often can recognize the letters of a word that has been transformed either temporally or spatially, but still be unable to identify the word itself. This identifies for us the fact that recognizing a word involves processes of a different kind from mere recognition of its constituent letters. The second observation emphasizes the "program" nature of reading: the subjects who read twenty-five pages of transformed text, described above, were also tested with one page or normal English text at the beginning of the first and at the end of the last day's testing. Presented with a page of normal English text to read after having read several pages of transformed text, the subjects characteristically were unable to read the normal text, taking as long as thirty seconds to identify the first word. But once recognized, the normal text was read off without impairment.

Two qualitative observations finish this summary. One is that a subject often can recognize the letters of a word that has been transformed either temporally or spatially, but still be unable to identify the word itself. This identifies for us the fact that recognizing a word involves processes of a different kind from mere recognition of its constituent letters. The second observation emphasizes the "program" nature of reading: the subjects who read twenty-five pages of transformed text, described above, were also tested with one page or normal English

NEUROPSYCHOLOGY OF RECOGNITION AND INTERSENSORY ASPECTS OF READING

R. Wayne Jones and Thorne Shipley
Department of Ophthalmology
Bascom Palmer Eye Institute
University of Miami, School of Medicine

Reading is clearly an intersensory process. The maturational development of the prerequisite skills for reading involve the acquisition of an auditory recognition vocabulary followed by a speaking vocabulary. These two processes become a receptive (hearing) and motor (speaking) association to which visual configuration (printed word) is attached as the child learns to read.

Recent research has pointed to the importance of central auditory-receptive deficits in dyslexic children. Children with a central auditory-receptive deficit cannot be distinguished by pure tone audiometric screening techniques. Their difficulties become evident only as the complexity of the auditory recognition task increases or as the stimulus becomes masked or distorted. Clear differences are evident in normal and retarded readers when they are required to discriminate distorted or masked words. Further, discrimination of meaning is lost if the syllables of words are separated distinctly across time.

The importance of parallel central visual-receptive processes in the acquisition of reading ability has not been investigated to the same extent as has the auditory modality. Nor have the aspects of intersensory association of simultaneous auditory and visual stimulation been contrasted for adequate and non-adequate readers.

The contribution of ocular and optical defects to reading disability remains an unresolved question. Whereas Helen Robinson reports that visual anomalies were found in 73 percent of cases studied fully, these were considered as contributory causes of reading disability in 50 percent of cases. On the other hand, Helen Shimota reports a significantly higher percentage of visual anomalies in adequate readers than in retarded readers . The relationship between peripheral vision defects and cortical visual-receptive deficits is essentially unknown.

The Bascom Palmer Eye Institute houses the Department of Ophthalmology of the University of Miami School of Medicine. The research and diagnostic facilities make feasible a detailed investigation of the mechanisms underlying visual discrimination and visual recognition. Complete Ophthalmological and orthoptic examinations are available for each child studied. Location of the Institute in the medical school complex will allow for diagnostic screening by the departments of pediatrics, neurology and otolaryngology (including speech evaluation).

The Eye Institute has recently acquired an evoked potential computor. This device computes across time a quantitative measurement of cortical (occipital lobe) activity which is synchronous with a visual (or auditory) stimulus over and above normal on-going cortical activity. The evoked potential technique has never been utilized in the study of dyslexia. We feel it holds great promise.

In general, the proposed research project will study intellectually matched populations of normal and dyslexic children with regard to:

1. Visual discrimination (simple and complex)

2. Visual recognition (threshold levels)

- **a) effect of masking**
- **b) effect of blurring**
- **c) effect of temporal separation**
  - **1) of syllables in words**
  - **2) of sequential action**
- **d) tachtistiscopic recognition (simple, complex and overlaid figures)**

3. Auditory discrimination

4. Auditory recognition

- **a) effect of masking**
- **b) effect of blurring**
- **c) effect of temporal separation**
  - **1) of syllables in words**

5. The interaction effect of simultaneous intersensory stimulation of visual and auditory modalities will be studied for each of the experimental situations listed above. By presenting a blurred, masked or distorted visual stimulus simultaneously with a blurred, masked or distorted sound, the threshold of recognition should be enhanced. The degree of enhancement is predicted to be less for the dyslexic child. A comparison will be possible within groups between single and dual stimulation recognition thresholds.

6. Cortical responsivity to visual and auditory stimulation (evoked potential technique) will be quantitatively measured.

All children will receive an EEG, speech evaluation, ophthalmological and audiological evaluation. Level of reading proficiency will be ascertained by a consultant to the project with extensive experience in the diagnosis of reading problems.

EIDETIC IMAGERY IN CHILDREN—SUMMARY OF RESEARCH[1]

Ralph Norman Haber
Yale University

Some children (and a very few adults) are able to maintain a complete visual image of a stimulus from which they can describe the stimulus in detail. This eidetic imagery is notably different from most adult perception, in which any visual image of a stimulus fades almost immediately (lasting generally no more than a few hundred milliseconds) and a description of the stimulus must be based on a normally incomplete memory. Eidetic imagery has been differentiated from memory by its preservation of fine detail, by S's reports that a visual image still persists after the stimulus has been removed, and by behavior which indicates that S is indeed attending to such an image. It is distinguished from after-images by its long duration, by the ease of evocation from even low-contrast stimuli, by its positive representation of color, by its independence of visual fixation during inspection, and by the lack of effects of eye-movements during report of the image.

In the first stage of our research, all children in two elementary schools in New Haven were tested for the presence of eidetic imagery using a standardized procedure, to assess both the number of children possessing this kind of imagery, and something of the nature of the imagery itself.

Briefly, the testing consisted of showing each child a picture (one of four) for 30 seconds, removing it after he had thoroughly scanned and examined it, and then asking whether he could still see any image of the picture on the background where it had been. Prior to the presentation of the four pictures, the children were shown stimuli designed to elicit after-images, both to have a measure of after-images, but more importantly to demonstrate to the child what is expected of him. Careful observation of eye-movements were made during inspection and report of any imagery for each of the four pictures. A complete recall from memory of each picture was also obtained after whatever imagery there was had faded.

---

[1] This research has been supported by a grant from NIMH (MH-03244) during the past 5 years. My wife, Ruth B. Haber, has been a collaborator throughout the project.

While 55% of the children reported having an image to at least one of the pictures, only 8% (N=12 in the second school where most of the detailed analyses were completed) reported images to all of the stimuli which met the criteria for eidetic imagery. The shortest of their images were 40 seconds, while the average was over three minutes, and nearly all were positively colored. Each of these images were scannable during report, while none of the other Ss reported an image that could be scanned. Accuracy of detail was rated on a nine-point scale from a tape recording of S's report: the eidetic images were nearly perfect, in that S could not only report all of the objects in the pictures, but their orientations and finer attributes. For example, in one picture, all of the feathers worn by each of ten Indians could be counted correctly, the colors in each of the blankets identified, and the arm positions and expressions of each person indicated. It would be very difficult to differentiate whether the child was giving his report from an image of the stimulus or from the stimulus itself. In contrast, the images reported by the other Ss were greatly impoverished, were often of a shadow or film color, or of single objects without detail.

The twelve eidetic children ranged from eight to twelve years of age. Half of the eidetic children were boys, and half were Negro (the same proportions as in the schools). As a partial longetudinal study, nine of these children were retested one year and again two years later. Eight of the nine were still eidetic, and to the same extent on both further testings.

We are just completing intensive formal psychological testing, including intelligence tests and projective evaluations. We are planning detailed interviews with the parents, teachers and the children themselves. These will include not only questions regarding the eidetic imagery directly (all twelve were quite aware of this ability—and think all children can see this way), but also whether the parents have noticed it, and if so, when, and how it has affected other cognitive skills especially learning to read and form concepts.

The second line of research is more perceptual, and concerns the use of these eidetic children as Ss in experimental tests of the duration of imagery, using procedures we have developed to measure the duration of short-term memory, and in tests of recovery of unavailable memory through the use of association tasks as a recovery aid.

RESEARCH PLANS AND PRELIMINARY RESULTS RELEVANT TO PROJECT LITERACY

Anne D. Pick
Macalester College
and
Herbert L. Pick, Jr.
University of Minnesota

Our present and proposed research relevant to Project Literacy derives from "graphic discrimination" studies and "reading-pronounciability" studies carried out as part of the Cornell reading project.

Studies of the discrimination of graphic forms. Previous investigations have shown that children between the ages of four years and eight years improve in their ability to make visual discriminations among letter-like forms. Further studies of improvement in such discriminations, both visually and tactually demonstrated the importance of "distinctive features" in learning such a task. It also appeared that conditions of comparison-successive or simultaneous-predicted the extent to which a type of "schema" learning accompanied distinctive feature learning. One of our current projects is an investigation of this phenomenon cross-modally.

In one experiment Ss (first graders) were trained to discriminate visually between "standard" letter-like forms and variations of these. These variations or comparison forms were transformations of the standard forms such as rotations and reversals, line and curve changes, perspective size changes. After training these Ss were given a transfer task in which they were asked to discriminate tactually between letter-like forms varying systematically from those they had in training. A second group of Ss learned to discriminate tactually between some letter-like forms and then were given a transfer task to which they were asked to discriminate visually between some forms varying systematically from those they had previously learned.

A preliminary analysis of these results suggests that it may be the transfer conditions and the extent to which these involve simultaneous or successive comparisons, rather than the training conditions, which affects the extent to which schema-type processes accompany the learning of important dimensions of difference in such a task.

One related project which we will begin shortly is a *developmental* study of the tactual discrimination of letter-like forms and the comparison of these results with the previous developmental study of visual discrimination of these forms. We hope that these data will suggest a model which will integrate all the present results.

Studies of the role of grapheme-phoneme correspondences in word perception. Previous investigations have shown that the extent to which there are high grapheme-phoneme correspondences in letter combinations affects their perceptibility. For both children and adults letter combinations have high grapheme-phoneme correspondences, i.e., letter combinations which are pronounceable, are more quickly and more accurately perceived than letter combinations which are unpronounceable. Currently, we are investigating the effect of pronounceability on perception for children who read Braille.

Pronounceable and unpronounceable letter combinations, written in Braille were presented individually to blind, Braille-reading students from ages nine to 21. The pronounceable and unpronounceable letter combinations consisted of different arrangements of the same letters. Ss were asked to read to themselves and spell aloud each word in succession as quickly as possible.

For all but one of 26 Ss, the pronounceable words were read more quickly than the unpronounceable words. Errors also showed a significant difference in favor of the pronounceable words despite the fact that Ss took more time to read the unpronounceable words and hence might have been expected to read them as accurately as the pronounceable words. The types of errors made by these Ss are interesting and we are attempting a systematic analysis of them.

Another investigation which will shortly be undertaken is relevant to both of the kinds of problems which we are studying. This project will be to obtain from both sighted Ss (working blindfolded) and blind Ss a confusion matrix for Braille forms. Ss will be asked to compare Braille forms with each other and to make same and difference judgments. The patterns of perceptual confusions which are made by both types of Ss will, we hope, suggest generalizations about tactual discrimination processes and further elucidate the kinds of errors made by Ss in the pronounceability study just described.

The study of the grapheme-phoneme correspondences in perception is leading us in one further direction. In order to shed some light on the mechanism of this apparently quite general facilitating effect of pronounceability on perception, we have recently begun a study which manipulates pronounceability as a subject variable. The study is being carried out in collaboration with Dr. Mildred Templin of the University of Minnesota, Institute of Child Development.[1] Dr. Templin has been conducting for the past several years a longitudinal study of speech pathology. These Ss are being compared in their ability to preceive visual and auditory verbal stimuli to other groups who have had speech difficulties but have overcome them as well as to groups who have never had any speech difficulties. Preliminary analysis of overall errors suggests that the present speech-difficulty groups are inferior in the perception of visual verbal stimuli to the normal groups and the improved groups.

1/ Mr. Robert Klein has participated in the planning of this study and had directed the data collection.

COMPREHENSION WITH USE OF PHONIC TEACHING METHODS

Janellen Huttenlocher
Center for Cognitive Studies
Harvard University

During the last few years I have been studying the development of formal reasoning in children aged six to twelve years. The children have worked on highly schematized concept formation tasks similar to those used in studies with adults, e.g. by Hovland and Weiss; Bruner, Goodnow and Austin. These problems all required the children to discover which one of a small set of binary attributes activated a light. Depending on the sequencing of positive and/or negative outcomes of instances on these problems, the number of inferential steps required to obtain answers varied. While small children were relatively successful in isolating these simple one-to-one relationships with sequences requiring few inferential steps, they were totally unsuccessful with those requiring several such steps. The sources of difficulty did not appear to result from inability to carry out any of the single inferences required but rather arose from the necessity to execute a sequence of such inferences.

These findings have aroused my interest in children's general capacity to hold onto and integrate sequences of elements in larger meaningful units. Obviously, such skills are required for learning to read. The child must hold sequences of phonemes until an entire word has been sounded and/or sequences of words until phrases and sentences are complete. I wonder whether children gain much of the meaning of passages while attempting to integrate units into new sequences or whether such passages must be repeated several times or require the aid of a teacher or picture.

Several allied questions arise. Assuming, for example, that phonic teaching methods are used:

1. How long a sequence of phonemes can the child sound out into a new sequence and be able to figure out the word he is sounding? Does the size of the population of letters to which they have been introduced affect this skill?
2. What effect does overlearning of units have in increasing the ability to integrate these units into sequences? Correlative with this question: Is the rapidity and ease with which letters may be sounded important for determining the meaning of words?
3. How well can children handle disjunctive possibilities for the sound of single letters? e.g. Does a letter known to have two alternative pronunciations, introduced early in a sequence, disrupt "holding" the entire sequence?

SUGGESTIONS FOR RESEARCH ON THE USE OF THE CHILD'S KNOWLEDGE OF SPOKEN LANGUAGE IN THE TEACHING OF READING AND WRITING

Rose R. Olver
Amherst College

To make maximum use of the child's well developed speaking knowledge of language in the teaching of reading and writing it seems important to give the child at the outset an awareness of the relationships of spoken and written language — for example, that both are forms of communication and that writing serves as a way of recording spoken language. This could be accomplished by presenting reading and writing as a "conversation game" — perhaps in a larger context where dialogue between tutor and learner may be carried out by speaking, acting out with gestures, drawing pictures, reading and writing, etc. This approach might well introduce the child to some of the potentials of written communication — that it provides a fairly permanent record, enables communication in absence of the communicator, and so forth — and should point up why some of the "rules" of reading and writing are necessary — such as punctuation marks to indicate pauses and intonation. In addition, such a written dialogue would provide a mechanism for immediate corrective feedback to the learner for mutual comprehension among the participants can be checked by judgments of whether statements given in response follow from correct understanding of prior statements or by the action consequences when statements include instructions to be carried out by tutor or learner. In the initial stages of reading and writing, where the learner's ability to produce statements with paper and pencil are not well enough developed for ease in playing such a "game", word cards might be devised from which the child (and the tutor) could select and build sequences.

In addition to engaging the child in a search for relations between spoken and written language, using the child's speaking knowledge of language in teaching reading and writing requires an examination of what indeed one has to build on in the attempt to establish correspondences between the printed page and the child's spoken language. Thus it seems of importance to determine how the child segments the flow of spoken language. By providing the child with a notation system for representing the units he forms he may be led to the more conventional units of written notation. If, for example, the child has some sense of an utterance or sentence as a segment of spoken language, he might be provided with a notation for the representation of this unit. From a set of such utterances in notational form, the child may be led to discover further subdivisions by noting what regularities occur within his segments. Thus, comparison of differences and regularities occur within sets of utterances as spoken and as written may give the child much of the information he needs to draw correspondences between the units of speaking and of writing.

Concurrent with the division of utterances into units, the child should begin the construction of new utterances by combining segments of previously produced sentences. This sort of activity may illustrate the useful units to employ in written notation and may bring the child to an understanding of the difference between lists of words and sentences.

It seems likely that this approach to the teaching of reading — since it stresses both the communication process and beginning where the child is in terms of the segmentation of speech — would involve emphasis on the utterance as a basic unit. Taking the utterance as a basic unit of organization for the teaching of reading and writing may enable the child to bring to the reading situation the ability he has in spoken language to integrate smaller units (phonemes, words, etc.) in a "planful" fashion and thus avoid losing the thought for the separate words or the words for the separate letters.

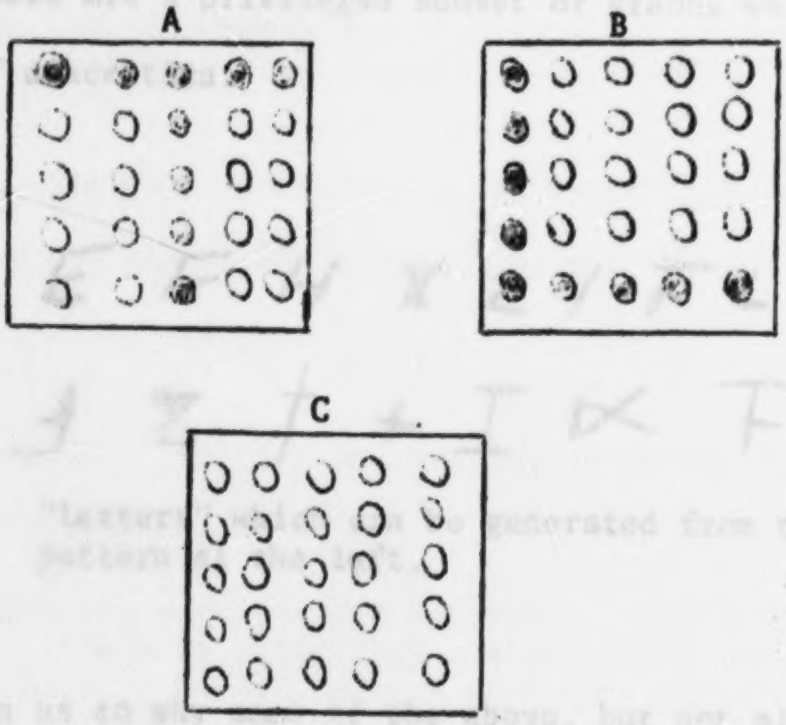
ELEVEN HYPOTHESES IN SEARCH OF A METHOD

Jerome S. Bruner*
Center for Cognitive Studies
Harvard University

Hypothesis 1. **There is a sharp difference between image space and information space. Reading involves learning to distinguish between information spaces, not image spaces.**

Experiment:

Bulb boards:



Task: Child was shown the two boards A and B, each of which had a letter picked out by lighted bulbs. Board C was unlighted but any single bulb could be illuminated by touching it. On each trial the bulb was wired so that the single lights forming either the letter shown on board A, or the letter shown on board B could be illuminated by touching the bulbs. The child's task was to discover which one of the two alternatives could be lighted (i.e. which of the two letters was 'on' the board).

Results: 4 year olds - pushed random buttons. When asked why he had pushed a button and then changed to another (when no light appeared) he would answer, "Because it wasn't there."

---

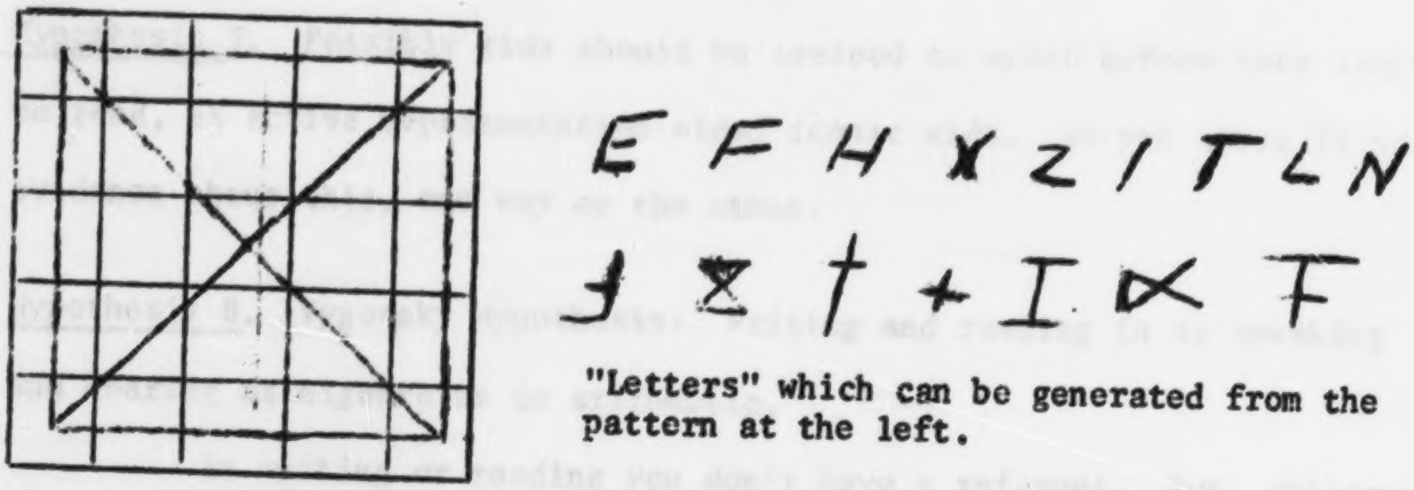
* Notes on a seminar talk delivered June 18, 1964, MIT Endicott House, Dedham, Massachusetts

Questions directed at trying to find out what "it" referred to didn't elicit much of an answer.

Older kids - at first would push the non-discriminating buttons (i.e. where the two letters would overlap). Then they would push discriminating lights (i.e. ones which would light if it were one of the letters, but not if it were the other).

Group data shows that the proportion of discriminating to non-discriminating responses increases with age. Individual data shows that the change from non-discriminating to discriminating responses comes with a bang.

Hypothesis 2. English letters are a privileged subset of graphs which can be generated by a set of diacritica.



"Letters" which can be generated from the pattern at the left.

There is no pattern as to why some of the above, but not all of them are used in our notation. Once the rules for generation are known it may be easier to separate the selected ones from the non-selected.

Hypothesis 3. Perhaps practice in "babbling" in writing would make it easier for the kid to generate the alphabet.

Hypothesis 4. A subset of the alphabet may be discriminable in terms of certain oppositional contrasts.

Perhaps good teaching tactics might highlight contrasts relevant to alphabet choice. e.g. size does not matter, but right-facing vs. left-facing does—

C vs. Ɔ; E vs. Ǝ; R vs. ᴙ ; N vs. И .

Toys could be used to assist in discrimination.

Hypothesis 5. The Bloomfield Hypothesis: Letter discrimination must be learned in context. e.g.

Stop Spore
Step Store
Stip Snore
Stap Score

Hypothesis 6. Relevant rules for writing have not yet been learned for oral-oral discrimination. The child has not yet learned segmentation—he doesn't know what a word is.

> The child could be trained to practice segmentation in the spoken language. Until he has some basis for discriminating words in the oral flow, he has no basis for matching graphemes and phonemes.

Hypothesis 7. Possibly kids should be trained to write before they learn to read, as active representation aids, iconic aids. As yet there is no evidence about this, one way or the other.

Hypothesis 8. Vygotsky Hypothesis: Writing and reading is to speaking and hearing as algebra is to arithmetic.

> In writing or reading you don't have a referent. But, childrens' first words are for things in which they are in visual contact. Therefore, perhaps reading should be much more concretized—perhaps one should have the referent right there and have someone say it back to the child as he writes.

Hypothesis 9. In writing and reading as in speaking, there is a major problem with the functors. More concrete embodiment could be given to these.

Hypothesis 10. There is a need for a means by which the child can learn to use the redundancy of written English.

> Could give practice in this by taking out 30% of the letters in a passage and getting the kid to put them back in the right place. Redundancy is an essential property which allows for the scanning mechanism. "If God delivered to the king of Prussia as imperfect a mechanism as the human eye, the king would say to God, "Take it back and work on it for another year."."

Hypothesis 11. Self-consciousness about language helps learning. Therefore we should perhaps teach linguistics in the first grade.

PARTICIPANTS

Paul Ammon, Department of Child Development, Cornell University
Andrew Biemiller, Department of Child Development, Cornell University
Carol Bishop, Department of Psychology, Cornell University
Thomas Barrows, School of Education, University of Pennsylvania
Thomas Bower, Department of Psychology, Cornell University
Yvonne Brackbill, Department of Psychology, University of Denver
Jerome Bruner, Center for Cognitive Studies, Harvard University
Del Ellsworth, Department of Psychology, Univ. of Calif. Medical School
Matthew Erdelyi, Department of Psychology, Yale University
Ralph Haber, Department of Psychology, Yale University
Curtis Hardyck, Department of Psychology, Univ. of Calif. Medical School
Julian Hochberg, Department of Psychology, Cornell University
Janellen Huttenlocher, Center for Cognitive Studies, Harvard University
Wayne Jones, Bascom-Palmer Eye Institute, Univ. of Miami Medical School
Robert Klein, Institute of Child Development, University of Minnesota
Paul Kolers, Research Laboratory of Electronics, Mass. Institute of Technology
Barbara Kravitz, Center for Cognitive Studies, Harvard University
Harry Levin, Project Literacy, Cornell University
Larry Lintz, Department of Psychology, University of Denver
Nancy S. Meltzer, Project Literacy, Cornell University
Rose Olver, Department of Psychology, Amherst College
Timothy Parsons, Department of Psychology, Amherst College
Anne Pick, Macalester College
Herbert Pick, Jr., Institute of Child Development, University of Minnesota
Thomas Romberg, School Mathematics Study Group, Stanford University
Thorne Shipley, Bascom-Palmer Eye Institute, Univ. of Miami Medical School
Raymond Starr, Department of Psychology, University of Denver
Joanna Williams, School of Education, University of Pennsylvania
John Wright, Institute of Child Development, University of Minnesota
Carolyn Zahn, Institute of Child Development, University of Minnesota

Frances Biemiller, Recorder
Mary Blomgren, Secretary